# How Machinery Data Helped Shell Minimize Downtime

## A Case for Integrating Machine Condition and Process Information

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A Bently Nevada Data Manager® 2000 (DM2000) Machinery Management System soon proved its value after its installation in the control room of a Shell ethylene plant. Thanks to the increased diagnostic capabilities provided by DM2000, the actual cause of an unexpected shutdown of the cracked gas compression unit at this plant was quickly identified. This machine train consists of a steam turbine driving three separate compressor casings: a first stage, a combined second and third stage, and a fourth stage. The unit is the core of the ethylene plant and is used to process the gas coming from the cracking installation.

**Ethylene plant cracker furnaces and distillation column.**

At approximately 7:30 one morning, the Bently Nevada 3300 Machinery Protection System detected a sudden change in the axial position of the combined second and third stage compressor rotor. Since the Alert and Danger alarm setpoints were exceeded, the Protection System's integral relays activated, shutting the machine down. Shortly after this incident, the Operations shift supervisor contacted the plant's Rotating Equipment Department and asked them to investigate the machine problem that had apparently occurred on the cracked gas compressor. He also asked if, and when, the machine could be restarted.

Although the Danger alarm status disappeared almost immediately after the unit tripped, the situation appeared to be serious, as the Alert alarm status remained on even when the machine had come to a standstill. Analyzing the machine data provided on their networked desktop computers by the DM2000 system, the Rotating Equipment Engineers were quickly able to evaluate the mechanical behavior of the machine, at times just before the trip took place and during the subsequent rundown.They were also able to compare the hot standstill gap voltages and the slow roll characteristics with trend and reference data, stored in the DM2000 computer.

The vibration data sampled by DM2000 did not show any indication of an existing machine problem. However, the plots of the axial rotor position confirmed that there had been a major shift that led to the monitor alarms and the subsequent shutdown. The shift supervisor was informed that no mechanical cause for this rotor axial position change could be found. Based

**Cracked gas compressor during a previous maintenance turnaround.**

on this conclusion, the focus of the investigation needed to be on the process side.

Printouts from the plant's process control system had to be manually reviewed, and two problems were found that caused the unit to trip. A fast change in the setpoint of a process parameter and an improperly functioning anti-surge valve had caused the machine to surge. It was then concluded that, due to the surge, the extreme thrust forces exerted on the axial bearing had eliminated any remaining clearances between the various bearing parts and its housing. The resulting rotor position change, in combination with relatively tight Alert and Danger alarm setpoints, then caused the machine to trip. Because the machine's integrity had been confirmed by the information from the DM2000, the Rotating Equipment Engineer advised slightly increasing the margin on the axial Alert and Danger settings, and the shift supervisor was notified that it was safe to restart the machine.

Information from the DM2000 system, the final inspection results from the valve, and relevant process data had made the decision about restarting the cracked gas compressor relatively easy. Operations started the unit and ran it at normal operating conditions without further incident and unit downtime was limited to two hours. Without the conclusive information from the DM2000 system, the condition of the compressor's thrust bearing would have had to be verified first, and the downtime would have been approximately 48 hours, with production losses exceeding USD 1,000,000.

Could this situation have been improved and the amount of downtime reduced even more? Definitely. The main reason for the two-hour delay was the need to manually review process data. If the relevant process data had also been made available to the DM2000 system (the ability to integrate process and machine data is a standard DM2000 capability) the correlation between the dynamic behavior of the cracked gas compression unit and the status of critical process parameters would have been apparent much sooner. Having all relevant machine and process data available in the Rotating Equipment Engineer's office would have enhanced Shell's Machinery Management capabilities even more and further reduced the time the unit was out of production.